Solid Waste Management and Greenhouse Gases: A Life-Cycle Assessment of Emissions and Sinks

2005 Emission Factor Roadmap

The U.S. EPA has conducted streamlined life-cycle analyses for most of the materials found in municipal solid waste. The purpose of these analyses is to provide waste managers with information on the greenhouse gas (GHG) emissions associated with various waste management practices. The functional output of these analyses is a suite of GHG emission factors as presented in a research report and in two user-friendly tools. The most recent edition of the report, *Solid Waste Management and Greenhouse Gases: A Life-Cycle Assessment of Emissions and Sinks*, was released in 2002 and it provides details on the methodology used to develop the emission factors. The report is available online at http://yosemite.epa.gov/oar/globalwarming.nsf/content/ActionsWaste.html, under the "publications" heading.

Since the release of the latest report, adjustments and improvements have been made to the underlying data and methodology supporting the life-cycle emission factors. These improvements are reflected in the latest versions of the WAste Reduction Model (WARM) and the Recycled Content (ReCon) Tool, both of which are available to the public. These tools help waste managers and product purchasers to model their situations to better understand the climate and energy implications of their waste management and recycled content purchasing decisions. WARM and ReCon are also available online at http://yosemite.epa.gov/oar/globalwarming.nsf/content/ActionsWaste.html, under the "tools" heading. Because the full report has not been updated to reflect these changes, there are some discrepancies between the emission factors contained in the report and the emission factors that are utilized by the modeling tools. This addendum provides a brief explanation of the changes made to the underlying data and provides details on the latest emission factors being utilized by the tools.

The primary changes and improvements to the life-cycle analysis since the 2002 report include the following:

- Added several new product and material types, including copper wire (81 KB PDF), carpet and personal computers (346 KB PDF), clay bricks and aggregate (775 KB PDF), fly ash (585 KB PDF), and mixed metals. As information on these additional material types became available, the list of material types has been expanded to provide greater capture of the municipal solid waste stream.
- Incorporated and/or developed emission factors for grass, leaves, and branches in the summary tables for all the waste management options.[1]
- Updated the national average fuel mix for utility-generated electricity based on information from the DOE, EIA, "Annual Energy Review: 2003" on electric utility consumption of fossil fuels.
- Updated the characterization of the municipal waste stream based on the *2003 Municipal Solid Waste in the United States: Facts and Figures* report. This characterization study is used to develop emission factors for several of the "mixed" material types (e.g., mixed metals, mixed MSW).
- Revised the "current mix" values for virgin and recycled content of materials based on data obtained from Franklin Associates Ltd.
- Incorporated open loop recycling of corrugated cardboard and mixed paper into the life-cycle methodology. This provides a more accurate picture of the recycling of these materials such

[1] Emission factors for grass, leaves, and branches were available for only the landfilling waste management option in the 1998 and 2002 *Solid Waste Management and Greenhouse Gases* reports.

that recycled corrugated cardboard does not always go into the production of new corrugated cardboard.

- Added retail transportation (factory to point-of-sale) to the methodology utilizing commodity transportation data from the U.S. Census Bureau. (more information 57 KB PDF)
- Updated data on the behavior of organic materials in the landfill environment based on recent studies by Dr. Barlaz of NC State University. (more information 93 KB PDF)

Reports, addenda, and memoranda providing details on the above changes are available online at http://yosemite.epa.gov/oar/globalwarming.nsf/content/ActionsWasteToolsSWMGHGreport.html. It should be noted that the fundamental aspects of the methodology reported in the 2002 report remain unchanged and this addendum has been developed as a mechanism to communicate changes in the GHG emission factors that have occurred since the publication of the 2002 report.

The following pages provide the revised emission factors as of June 2005 for each of the waste management options.

Source Reduction

Table 1 presents the current net emission factors for source reduction as well as the components used to generate the net emission factors. Rows and columns that are shaded in gray highlight new material types and components that have changed since the full report was created. Each of the areas shaded in gray is described briefly below.

- The "current mix" values for virgin and recycled content of materials have been revised based on data obtained from Franklin Associates Ltd., which impacts all source reduction factors based on the current mix.
- Seven new material types have been added including copper wire (81 KB PDF), carpet and personal computers (346 KB PDF), clay bricks and aggregate (775 KB PDF), fly ash (585 KB PDF), and mixed metals.
- The retail transportation component was added to the emission factors for manufacturing energy utilizing commodity transportation data from the Census Bureau. (more information 57 KB PDF)
- Several net emission factors have changed due to a combination of the factors listed above.

To calculate the net emission factors for source reduction, one must add two components: avoided emissions from raw material acquisition and manufacturing, and forest carbon sequestration, as described in section 4.1 of the 2002 report. The components are calculated for two possible situations: 1) when source reduction displaces the current mix of virgin and recycled inputs and 2) when source reduction displaces 100 percent virgin inputs. To calculate the net emission factor where source reduction displaces the current mix, the appropriate raw material acquisition and manufacturing component (i.e., column 2) is added to the appropriate forest carbon sequestration benefit (i.e., column 5). To calculate the net emission factor where source reduction displaces 100 percent virgin materials, do the same calculation, but for the components that reflect displacement of 100 percent virgin materials (i.e., add columns 3 and 6). Waste management emissions avoided can also be included in the calculation of the net emission factors at the user's discretion and would be dependant on the waste management option selected.

The methodology used to calculate raw material acquisition and manufacturing emissions can be found in the 2002 report, Chapter 2. In general, this component incorporates emissions from the energy used to obtain the raw (or recycled) materials and the energy used to manufacture the various products, including transportation. Since less of a material is made when a product is source reduced, emissions from raw material acquisition and manufacturing are avoided. Forest carbon sequestration benefits for wood and paper products are realized when materials are source reduced since trees that would otherwise have been harvested are left standing. In the short term, a reduction in harvesting results in a larger quantity of carbon remaining sequestered since the standing trees continue to grow and sequester carbon through photosynthesis. Additional information on the methodology used to estimate forest carbon sequestration can be found in Chapter 3 of the 2002 report.

Table 1: Source Reduction (GHG Emissions in MTCE/Ton) Emission Factors as of June 2005

Material	Raw Material Acquisition and Manufacturing		Waste Management Emissions	Forest Carbon Sequestration		Net Emissions	
	Source Reduction Displaces Current Mix of Virgin and Recycled Inputs	Source Reduction Displaces 100% Virgin Inputs		Source Reduction Displaces Current Mix of Inputs	Source Reduction Displaces 100% Virgin Inputs	Source Reduction Displaces Current Mix of Inputs	Source Reduction Displaces 100% Virgin Inputs
Aluminum Cans	(2.45)	(4.67)	0.00	0.00	0.00	(2.45)	(4.67)
Steel Cans	(0.87)	(1.01)	0.00	0.00	0.00	(0.87)	(1.01)
Copper Wire	(2.05)	(2.07)	0.00	0.00	0.00	(2.05)	(2.07)
Glass	(0.16)	(0.18)	0.00	0.00	0.00	(0.16)	(0.18)
HDPE	(0.49)	(0.54)	0.00	0.00	0.00	(0.49)	(0.54)
LDPE	(0.63)	(0.65)	0.00	0.00	0.00	(0.63)	(0.65)
PET	(0.58)	(0.59)	0.00	0.00	0.00	(0.58)	(0.59)
Corrugated Cardboard	(0.24)	(0.23)	0.00	(0.48)	(0.73)	(0.72)	(0.96)
Magazines/Third-class Mail	(0.47)	(0.47)	0.00	(0.70)	(0.73)	(1.17)	(1.20)
Newspaper	(0.54)	(0.60)	0.00	(0.56)	(0.73)	(1.11)	(1.33)
Office Paper	(0.29)	(0.28)	0.00	(0.70)	(0.73)	(0.99)	(1.02)
Phonebooks	(0.69)	(0.69)	0.00	(0.73)	(0.73)	(1.43)	(1.43)
Textbooks	(0.61)	(0.61)	0.00	(0.70)	(0.73)	(1.32)	(1.35)
Dimensional Lumber	(0.05)	(0.05)	0.00	(0.50)	(0.50)	(0.55)	(0.55)
Medium-density Fiberboard	(0.10)	(0.10)	0.00	(0.50)	(0.50)	(0.61)	(0.61)
Food Discards	NA	NA	NA	NA	NA	NA	NA
Yard Trimmings	NA	NA	NA	NA	NA	NA	NA
Grass	NA	NA	NA	NA	NA	NA	NA
Leaves	NA	NA	NA	NA	NA	NA	NA
Branches	NA	NA	NA	NA	NA	NA	NA
Mixed Paper							
Broad Definition	NA	NA	NA	NA	NA	NA	NA
Residential Definition	NA	NA	NA	NA	NA	NA	NA
Office Paper Definition	NA	NA	NA	NA	NA	NA	NA
Mixed Metals	NA	NA	NA	NA	NA	NA	NA
Mixed Plastics	NA	NA	NA	NA	NA	NA	NA
Mixed Recyclables	NA	NA	NA	NA	NA	NA	NA
Mixed Organics	NA	NA	NA	NA	NA	NA	NA
Mixed MSW	NA	NA	NA	NA	NA	NA	NA
Carpet	(1.12)	(1.12)	0.00	0.00	0.00	(1.12)	(1.12)
Personal Computers	(15.84)	(15.84)	0.00	0.00	0.00	(15.84)	(15.84)
Clay Bricks	(0.08)	(0.08)	0.00	0.00	0.00	(0.08)	(0.08)
Aggregate	NA	NA	NA	NA	NA	NA	NA
Fly Ash	NA	NA	NA	NA	NA	NA	NA

Note: Emission factors may not appear to have changed due to rounding.

Recycling

Table 2 presents the current net emission factors for recycling as well as the components used to generate the net emission factors. Rows, columns, and cells that are shaded in gray highlight new material types, components that have been updated, or revisions to individual factors. Each of the areas shaded in gray is described briefly below.

- Seven new material types have been added including copper wire (81 KB PDF), carpet and personal computers (346 KB PDF), clay bricks and aggregate (775 KB PDF), fly ash (585 KB PDF), and mixed metals.
- Open loop recycling of corrugated cardboard and mixed paper has been incorporated into the life cycle methodology. This provides a more accurate picture of the recycling of these materials in that recycled corrugated cardboard does not always go into the production of new corrugated cardboard.
- The benefits of recycling aluminum have been revised. The process energy values were updated to incorporate revised fuel mix data for the production of aluminum sheet and transportation energy values were also updated based on energy data obtained from a personal computer life-cycle analysis performed by Franklin Associates Ltd. The process non-energy values were revised to incorporate additional anode production data provided by Franklin Associates Ltd. along with the latest data on perfluorocarbon emission characteristics for aluminum smelting.
- Several net emission factors have changed due to a combination of the changes described above.

The recycling net emission factors can be calculated by summing the four components from Table 2: process energy, transportation energy, process non-energy, and forest carbon sequestration as described in section 4.2 of the 2002 report.

The three recycled input credit components represent the difference in emissions between manufacturing a material using 100 percent recycled inputs and manufacturing an equivalent amount of the material (accounting for loss rates) using 100 percent virgin inputs. Broadly speaking, recycling reduces the amount of energy required to manufacture materials (compared to manufacture with 100 percent virgin inputs) and typically leads to reduced process energy emissions. Process energy emissions are primarily CO_2 and include emissions generated during the raw material acquisition and manufacturing process. Transportation emissions include emissions generated during transport of raw materials and intermediate products to the final manufacturing or fabrication facility. For recycled inputs this includes transportation from curbside to the MRF facility and to the final plant where recycled inputs are used. Process non-energy emissions are emissions generated during raw material acquisition and manufacturing not attributable to direct energy use. The process non-energy sources include conversion of limestone to lime CH_4 emissions from natural gas pipelines and the processing of natural gas that are associated with the manufacture of plastic products, and perfluorocarbon emissions from aluminum smelting. Additional details on the methodology used to calculate these components can be found in Chapter 2 of the 2002 report.

Forest carbon sequestration benefits are realized for wood and paper products when materials are recycled since trees that would otherwise have been harvested are left standing. In the short term, a reduction in harvesting results in a larger quantity of carbon remaining sequestered since the standing trees continue to grow and sequester carbon through photosynthesis. Additional information on the methodology used to estimate forest carbon sequestration can be found in Chapter 3 of the 2002 report.

Table 2: Recycling of Post-Consumer Material (GHG Emissions in MTCE/Ton)
Emission Factors as of June 2005

Material	Recycled Input Credit*			Forest Carbon Sequestration	Net Emissions (Post-Consumer)
	Process Energy	Transportation Energy	Process Non-Energy		
Aluminum Cans	(3.06)	(0.12)	(0.90)	0.00	(4.07)
Steel Cans	(0.48)	(0.01)	0.00	0.00	(0.49)
Copper Wire	(0.33)	0.03	0.00	0.00	(0.30)
Glass	(0.03)	(0.00)	(0.04)	0.00	(0.08)
HDPE	(0.34)	0.00	(0.04)	0.00	(0.38)
LDPE	(0.43)	0.00	(0.04)	0.00	(0.47)
PET	(0.40)	0.00	(0.02)	0.00	(0.42)
Corrugated Cardboard	0.00	(0.01)	(0.00)	(0.73)	(0.75)
Magazines/Third-class Mail	(0.00)	0.00	0.00	(0.73)	(0.74)
Newspaper	(0.21)	(0.01)	0.00	(0.73)	(0.95)
Office Paper	0.06	0.00	(0.00)	(0.73)	(0.68)
Phonebooks	(0.18)	0.00	0.00	(0.73)	(0.91)
Textbooks	(0.01)	0.00	0.00	(0.73)	(0.75)
Dimensional Lumber	0.02	0.00	0.00	(0.69)	(0.67)
Medium-density Fiberboard	0.01	0.00	0.00	(0.69)	(0.67)
Food Discards	NA	NA	NA	NA	NA
Yard Trimmings	NA	NA	NA	NA	NA
Grass	NA	NA	NA	NA	NA
Leaves	NA	NA	NA	NA	NA
Branches	NA	NA	NA	NA	NA
Mixed Paper					
Broad Definition	(0.10)	(0.03)	(0.00)	(0.73)	(0.86)
Residential Definition	(0.10)	(0.03)	(0.00)	(0.73)	(0.86)
Office Paper Definition	(0.08)	(0.02)	(0.00)	(0.73)	(0.83)
Mixed Metals	(1.38)	(0.05)	(0.31)	0.00	(1.75)
Mixed Plastics	(0.38)	0.00	(0.03)	0.00	(0.41)
Mixed Recyclables	(0.12)	(0.01)	(0.02)	(0.63)	(0.78)
Mixed Organics	NA	NA	NA	NA	NA
Mixed MSW	NA	NA	NA	NA	NA
Carpet	(1.52)	(0.02)	(0.47)	0.00	(2.01)
Personal Computers	(0.50)	(0.01)	(0.24)	0.00	(0.75)
Clay Bricks	NA	NA	NA	NA	NA
Aggregate	(0.00)	(0.00)	0.00	0.00	(0.00)
Fly Ash	(0.12)	0.00	(0.12)	0.00	(0.24)

* Material that is recycled after use is then substituted for virgin inputs in the production of new products. This credit represents the difference in emissions that results from using recycled inputs.
Note: Emission factors may not appear to have changed due to rounding.

Composting

Table 3 presents the current net emission factors for composting as well as the components used to generate the net emission factors. Rows and columns that are shaded in gray highlight new material types or components that have been added. Each of the areas shaded in gray is described briefly below.

- Compost emission factors were developed for grass, leaves and branches.
- New columns were added to the summary table to accommodate potential CO_2 and CH_4 emissions from composting.
- The changes described above had no impact on the net emission factors.

Net emissions from composting are calculated by summing the four components of the composting emission factors: transportation, compost CO_2, compost CH_4, and soil carbon sequestration. Transportation emissions represent emissions from the collection and transportation of organic materials to the composting site and from mechanical turning of the compost pile. Compost CO_2 represents the biogenic CO_2 emissions associated with decomposition, during the composting process and after compost is applied to soil. Since these emissions are biogenic, they were not explicitly included in the summary table in the 2002 report although they are discussed within chapter 5. Compost CH_4 emissions reflect the potential CH_4 emissions from anaerobic decomposition of compost. However, when managed properly, no CH_4 is generated and therefore in our default analysis, CH_4 emissions are zero. Soil carbon sequestration represents the potential carbon storage benefits of applying compost to degraded agricultural soils. For additional information on the methodology used to generate these components, refer to Chapter 5 of the 2002 report.

Table 3: Centralized Composting of Post-Consumer Material (GHG Emissions in MTCE/Ton)
Emission Factors as of June 2005

Material	Transportation to Composting	Compost CO_2	Compost CH_4	Soil Carbon Sequestration	Net Emissions (Post-Consumer)
Aluminum Cans	NA	NA	NA	NA	NA
Steel Cans	NA	NA	NA	NA	NA
Copper Wire	NA	NA	NA	NA	NA
Glass	NA	NA	NA	NA	NA
HDPE	NA	NA	NA	NA	NA
LDPE	NA	NA	NA	NA	NA
PET	NA	NA	NA	NA	NA
Corrugated Cardboard	NA	NA	NA	NA	NA
Magazines/Third-class Mail	NA	NA	NA	NA	NA
Newspaper	NA	NA	NA	NA	NA
Office Paper	NA	NA	NA	NA	NA
Phonebooks	NA	NA	NA	NA	NA
Textbooks	NA	NA	NA	NA	NA
Dimensional Lumber	NA	NA	NA	NA	NA
Medium-density Fiberboard	NA	NA	NA	NA	NA
Food Discards	0.01	0.00	0.00	(0.07)	(0.05)
Yard Trimmings	0.01	0.00	0.00	(0.07)	(0.05)
Grass	0.01	0.00	0.00	(0.07)	(0.05)
Leaves	0.01	0.00	0.00	(0.07)	(0.05)
Branches	0.01	0.00	0.00	(0.07)	(0.05)
Mixed Paper					
Broad Definition	NA	NA	NA	NA	NA
Residential Definition	NA	NA	NA	NA	NA
Office Paper Definition	NA	NA	NA	NA	NA
Mixed Metals	NA	NA	NA	NA	NA
Mixed Plastics	NA	NA	NA	NA	NA
Mixed Recyclables	NA	NA	NA	NA	NA
Mixed Organics	0.01	0.00	0.00	(0.07)	(0.05)
Mixed MSW	NA	NA	NA	NA	NA
Carpet	NA	NA	NA	NA	NA
Personal Computers	NA	NA	NA	NA	NA
Clay Bricks	NA	NA	NA	NA	NA
Aggregate	NA	NA	NA	NA	NA
Fly Ash	NA	NA	NA	NA	NA

Note: Emission factors may not appear to have changed due to rounding.

Combustion

Table 4 presents the current net emission factors for combustion as well as the components used to generate the net emission factors. Rows, columns, and cells that are shaded in gray highlight new material types, components that have been updated, or revisions to individual factors. Each of the areas shaded in gray is described briefly below.

- Avoided Utility Emissions have been revised as a result of the update to the national average fuel mix for utility-generated electricity mentioned above.
- Seven new material types have been added including copper wire (81 KB PDF), carpet and personal computers (346 KB PDF), clay bricks and aggregate (775 KB PDF), fly ash (585 KB PDF), and mixed metals.
- Combustion emission factors were developed for grass, leaves and branches.
- The steel recovery value for mixed recyclables has been updated based on revised information on municipal solid waste characterization from the *2003 Municipal Solid Waste in the United States: Facts and Figures* report.
- Net emission factors have changed due to the changes described above.

To calculate the net emission factors for combustion, one must add the five components in Table 4: transportation, CO_2 from combustion, N_2O from combustion, avoided utility emissions, and steel recovery. Transportation represents the emissions generated from transportation of waste to the waste to energy (WTE) plant and transportation of ash from the WTE plant to a landfill. CO_2 from combustion represents the CO_2 emissions from combustion of the non-biomass components of MSW (e.g., plastic, textiles, rubber). N_2O from combustion represents the N_2O emissions that result from combustion of the MSW components that contain nitrogen (e.g., paper, wood, and organic materials). The avoided utility component represents an estimate of the emissions avoided from the use of electricity generated by a WTE facility rather than electricity generated by a utility. Steel recovery represents the avoided CO_2 emissions from increased steel recycling made possible by steel recovery that is commonly utilized at WTE plants. Additional information on the methodology used to calculate these components can be found in Chapter 6 of the 2002 report.

Table 4: Combustion of Post-Consumer Material (GHG Emissions in MTCE/Ton) Emission Factors as of June 2005

Material	Transportation to Combustion	CO_2 from Combustion	N_2O from Combustion	Avoided Utility Emissions	Steel Recovery	Net Emissions (Post-Consumer)
Aluminum Cans	0.01	0.00	0.00	0.01	0.00	0.02
Steel Cans	0.01	0.00	0.00	0.01	(0.43)	(0.42)
Copper Wire	0.01	0.00	0.00	0.01	0.00	0.02
Glass	0.01	0.00	0.00	0.01	0.00	0.01
HDPE	0.01	0.76	0.00	(0.52)	0.00	0.25
LDPE	0.01	0.76	0.00	(0.52)	0.00	0.25
PET	0.01	0.56	0.00	(0.27)	0.00	0.29
Corrugated Cardboard	0.01	0.00	0.01	(0.20)	0.00	(0.18)
Magazines/Third-class Mail	0.01	0.00	0.01	(0.15)	0.00	(0.13)
Newspaper	0.01	0.00	0.01	(0.22)	0.00	(0.21)
Office Paper	0.01	0.00	0.01	(0.19)	0.00	(0.17)
Phonebooks	0.01	0.00	0.01	(0.22)	0.00	(0.21)
Textbooks	0.01	0.00	0.01	(0.19)	0.00	(0.17)
Dimensional Lumber	0.01	0.00	0.01	(0.23)	0.00	(0.22)
Medium-density Fiberboard	0.01	0.00	0.01	(0.23)	0.00	(0.22)
Food Discards	0.01	0.00	0.01	(0.07)	0.00	(0.05)
Yard Trimmings	0.01	0.00	0.01	(0.08)	0.00	(0.06)
Grass	0.01	0.00	0.01	(0.08)	0.00	(0.06)
Leaves	0.01	0.00	0.01	(0.08)	0.00	(0.06)
Branches	0.01	0.00	0.01	(0.08)	0.00	(0.06)
Mixed Paper						
Broad Definition	0.01	0.00	0.01	(0.20)	0.00	(0.18)
Residential Definition	0.01	0.00	0.01	(0.20)	0.00	(0.18)
Office Paper Definition	0.01	0.00	0.01	(0.18)	0.00	(0.16)
Mixed Metals	0.01	0.00	0.00	0.01	(0.28)	(0.27)
Mixed Plastics	0.01	0.67	0.00	(0.41)	0.00	0.27
Mixed Recyclables	0.01	0.02	0.01	(0.18)	(0.01)	(0.16)
Mixed Organics	0.01	0.00	0.01	(0.07)	0.00	(0.06)
Mixed MSW	0.01	0.10	0.01	(0.14)	(0.01)	(0.03)
Carpet	0.01	0.47	0.00	(0.38)	0.00	0.10
Personal Computers	0.01	0.10	0.00	(0.04)	(0.12)	(0.05)
Clay Bricks	0.01	NA	NA	NA	NA	NA
Aggregate	NA	NA	NA	NA	NA	NA
Fly Ash	NA	NA	NA	NA	NA	NA

Values are for mass burn facilities with national average rate of ferrous recovery.
Note: Emission factors may not appear to have changed due to rounding.

Landfilling

Table 5 presents the current net emission factors for landfilling as well as the components used to generate the net emission factors. Rows, columns, and cells that are shaded in gray highlight new material types, components that have been updated, new components, or revisions to individual factors. Each of the areas shaded in gray is described briefly below.

- Avoided CO_2 emissions from energy recovery have been added to the summary table since the 2002 report. In addition, these factors have been revised as a result of the update to the national average fuel mix for utility-generated electricity mentioned above.
- Seven new material types have been added including copper wire (81 KB PDF), carpet and personal computers (346 KB PDF), clay bricks and aggregate (775 KB PDF), fly ash (585 KB PDF), and mixed metals.
- The total carbon sequestration factors for coated paper, newsprint, and grass were updated based on methodology changes suggested by Dr. Mort Barlaz of NCSU. (more information 93 KB PDF)
- The landfill CH_4 yields for corrugated cardboard, office paper, food discards, and branches were also updated based on methodology changes suggested by Dr. Mort Barlaz of NCSU. (more information 93 KB PDF)
- The changes described above resulted in changes to many of the net emission factors.

The landfilling net emission factor can be calculated by summing the four components in Table 5: transportation to the landfill, landfill CH_4, avoided CO_2 emissions from energy recovery, and landfill carbon sequestration. Transportation to the landfill represents the emissions generated from the combustion of fossil fuels used in vehicles to collect and transport the waste to the landfill. Landfill CH_4 represents the CH_4 generated during decomposition of waste in the landfill; these emissions are included in the total since degradation of the waste would not result in CH_4 emissions if not for deposition in landfills. Avoided CO_2 emissions from energy recovery reflect the utility emissions avoided when landfill gas is recovered and used to generate electricity. Landfill carbon sequestration represents the avoided emissions (or emissions sink) that results from incomplete decomposition of food discards, yard trimmings and paper. The carbon that does not decompose is stored in the landfill and therefore counted as an anthropogenic sink because it is being removed from the natural carbon cycle. For additional information on the methodology used to calculate these four components of the landfilling net emission factor, refer to Chapter 7 of the 2002 report.

Table 5: Landfilling of Post-Consumer Material (GHG Emissions in MTCE/Ton) Emission Factors as of June 2005

Material	Transportation to Landfill	Landfill CH_4	Avoided CO_2 Emissions from Energy Recovery*	Landfill Carbon Sequestration	Net Emissions (Post-Consumer)
Aluminum Cans	0.01	0.00	0.00	0.00	0.01
Steel Cans	0.01	0.00	0.00	0.00	0.01
Copper Wire	0.01	0.00	0.00	0.00	0.01
Glass	0.01	0.00	0.00	0.00	0.01
HDPE	0.01	0.00	0.00	0.00	0.01
LDPE	0.01	0.00	0.00	0.00	0.01
PET	0.01	0.00	0.00	0.00	0.01
Corrugated Cardboard	0.01	0.32	(0.01)	(0.22)	0.09
Magazines/Third-class Mail	0.01	0.17	(0.01)	(0.20)	(0.03)
Newspaper	0.01	0.15	(0.01)	(0.34)	(0.19)
Office Paper	0.01	0.54	(0.02)	(0.04)	0.48
Phonebooks	0.01	0.15	(0.01)	(0.34)	(0.19)
Textbooks	0.01	0.54	(0.02)	(0.04)	0.48
Dimensional Lumber	0.01	0.11	(0.01)	(0.21)	(0.09)
Medium-density Fiberboard	0.01	0.11	(0.01)	(0.21)	(0.09)
Food Discards	0.01	0.21	(0.01)	(0.02)	0.19
Yard Trimmings	0.01	0.11	(0.00)	(0.25)	(0.13)
Grass	0.01	0.12	(0.01)	(0.09)	0.03
Leaves	0.01	0.09	(0.00)	(0.39)	(0.29)
Branches	0.01	0.11	(0.01)	(0.21)	(0.09)
Mixed Paper					
Broad Definition	0.01	0.31	(0.01)	(0.21)	0.09
Residential Definition	0.01	0.30	(0.01)	(0.22)	0.07
Office Paper Definition	0.01	0.31	(0.01)	(0.17)	0.14
Mixed Metals	0.01	0.00	0.00	0.00	0.01
Mixed Plastics	0.01	0.00	0.00	0.00	0.01
Mixed Recyclables	0.01	0.26	(0.01)	(0.19)	0.06
Mixed Organics	0.01	0.16	(0.01)	(0.14)	0.02
Mixed MSW	0.01	0.16	(0.01)	(0.10)	0.07
Carpet	0.01	0.00	0.00	0.00	0.01
Personal Computers	0.01	0.00	0.00	0.00	0.01
Clay Bricks	0.01	0.00	0.00	0.00	0.01
Aggregate	0.01	0.00	0.00	0.00	0.01
Fly Ash	0.01	0.00	0.00	0.00	0.01

* Avoided CO_2 emissions from energy recovery were addressed in the 2002 report in section 7.3: Utility CO_2 Emissions Avoided but these emissions were not included in the report's summary table for landfilling (Exhibit 8-9 and 8-10).
Note: Emission factors may not appear to have changed due to rounding.